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OPTIMAL UTILIZATION OF THE FORAGE CROPS AND ORGANIZATION OF A FAMILY DAIRY FARM IN THE CORN BELT

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Optimal Utilization of the Forage Crops and Organization of a Family Dairy Farm in the Corn Belt

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INTRODUCTION

Rolling topography and forage crop production are part of the typical dairy farm image. Many farms in Ohio and in the United States fit into such an image—but not all. Dairy has been and is a very important livestock enterprise on many corn belt farms which are well adapted to an intensive system of grain production.

Efficient production and handling methods for both grain and forage crops have developed rapidly in recent years, and many significant improvements have been made. This revolution is by no means over, but these technological changes make it desirable for dairy farm operators to reconsider the organization and operation of their farms. Many of the decisions that must be made when adopting these new developments are extremely complex, often involving a major reoragnization of the entire farm business. These developments have a distinct advantage for some farm situations but not for others. A manager must constantly re-examine his farm plan and select practices that will permit him to attain his objectives efficiently.

PURPOSE

The purpose of this study was to develop the farm organization and method of handling the forage crops that would yield maximum family income for a one-man family dairy farm operation under selected corn belt conditions. Satisfying the nutritional needs of the dairy cow most efficiently was basic to this investigation. Handling of the forage crops needs detailed examination, but any such investigation must be conducted within the framework of the total farm organization. Consequently, possible sources of all feed inputs (grain and forage) for the dairy animals must be considered and compared relative to their costs and production requirements. In this study, the development of an "ideal" farm oragnization on corn belt farms was investigated with emphasis on the most economically desirable forage handling methods.

REVIEW OF LITERATURE

Few researchers have considered the development of the entire dairy farm organization. However, several studies have been made to deter-

[1]Based on data assembled and presented as an unpublished Ph.D. dissertation entitled, "Development of Optimum Forage-Handling Systems on One and Two-man Dairy Farms in Western Ohio," by David Lee Armstrong, The Ohio State University, 1960.

Acknowledgement: The authors would like to express their anppreciation to R. H. Baker, J. R. Tompkin of the Department of Agricultural Economics and Rural Sociology, and to members of the Department of Dairy Science and Agronomy of the Ohio State University for technical assistance and helpful suggestions throughout the project.

mine adjustments in dairy feeding programs that will permit more and better forages to be fed.

Smith (4) concluded that large quantities of high quality forage could be profitably fed to dairy cows. The most profitable forage systems included corn silage, grass legume silage, and hay. Although above average Wisconsin farms were studied, annual production per cow was 8,000 pounds of milk. Wilt and Hoglund (5) observed only small differences in milk production when high producing cows were fed different proportions of concentrate and roughage. Highest returns above feed costs were realized for dairy herds receiving a low cencentrate heavy forage ration. Hoglund and Wright (2) reported that dairymen with cows producing 10,000 pounds or more of milk could profitably feed more grain (one pound of grain to four pounds of milk) than men with cows producing 7,000 pounds of milk annually (one pound of grain to six or seven pounds of milk). Davis and Pratt (1) compared rotational and continuous methods of grazing at the Ohio Agricultural Experiment Station. They concluded that the grazing method had little effect on milk production per cow provided that the animals have an adequate quantity of forage. Shaudys, Sitterley, and Evans (3) found that under farm conditions a rotational grazing system required one-fourth to one-third more acres of meadow than a green chop system to maintain the same number of cows. However, the use of a rotational grazing system had an investment cost of $5 per cow and a green chop system had an investment cost of $30 per cow above a conventional pasture system. An intensive pasture system will increase income only if more cows are added to utilize the forage unless the cows were not adequately fed previously.

Published research findings have not always been in agreement. Differences in research conditions, level of production, size of the farm operation, land use capability, labor supply, capital available, and prices affect the desirability of any given production practice. In the past, many farmers considered the dairy enterprise primarily as a consumer of forage crops which were supplemented with a minimum amount of grain. Where the dairy cow has invaded the corn belt, the ideal dairy farm organization and methods of providing feed nutrients may be quite different than in other areas.

METHOD OF STUDY

Developing an Optimum Farm Organization

Optimum farm organizations were developed for selected production possibilities and resource availabilities using linear programming. An optimum farm organization was considered to be one that would yield maximum family income over time with a reasonable expenditure of human effort.

Linear programming is basically a system of comparing many repetitive budgets. It embodies solving a series of simultaneous equations to allocate limited resources among given activities or uses. The most profitable activities are used to the maximum extent permitted by the most limiting factor needed for production. The allocation of each

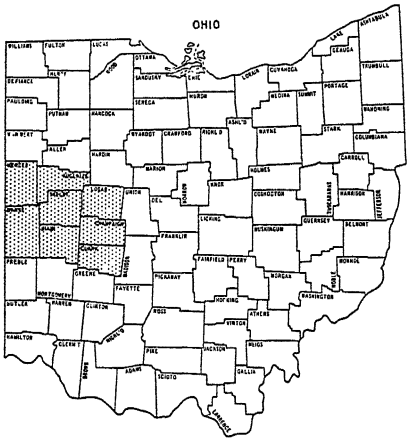


Fig. 1.—Dairy area in Western Ohio.

unit of a resource used is made by determining the production activities that will yield the highest possible dollar return.

Although primary emphasis was on the forage program, other related phases of the farm organization were considered in developing the most profitable farm organization. Each production activity included a consideration of all resources required such as: land, labor, capital, buildings, fence, and equipment needed for operation of the farm.

All resources used in production, except capital and labor, were assumed to be available in the quantities needed. Quality or productivity of the resources, was assumed typical of those available in eight west central corn belt dairy counties (see Figure 1). Income from dairy accounted for one-fifth of total farm income in these eight counties, and was equally important with swine during 1960. Level of managerial inputs was reflected in the production coefficients used. These were based on production performance achieved by the upper one-sixth of western Ohio (corn belt) dairy farm operators.

Labor available for farm use was limited to the amount the farm family could supply plus 400 hours of seasonal hired labor. Capital availability was limited to selected amounts, to determine the restrictive effect it has on the optimal dairy farm organization. The amounts of capital were varied from severely limiting to adequate.

Resource availabilities, except the level of managerial performance, the supply of productive labor, and selected amounts of available capital, were completely flexible. Other factors exerting an influence on the farm organization such as existing buildings, size of farm, quality of land, and institutions (habit or precedent) were eliminated. In practice, existing buildings and facilities impose restrictions on organizational adjustments because of the fixed capital investment. Elimination of this type of restriction permitted the development of an "ideal" organization that would enable the farm family to maximize income if they could select the exact quantity and quality of inputs needed. Fixity of

Table 1. Land Use in Eight Selected West Central Ohio Counties*

Use	Acres	Percent
Cropland	1,590,094	78
Permanent pasture	174,086	9
Woodland	145,499	7
Farmstead, roads, and other	124,685	6
Total	2,034,364	100

*Auglaize, Champaign, Clark, Darke, Logan, Mercer, Miami, Shelby

Source: Census of Agriculture U.S. Department of Commerce

existing resources or resource limitations may not make it economical for a farmer to completely reorganize his farm at a point in time. However, it is desirable that as adjustments in the organization are made that they enhance the long-time development of the farm. The use of such an "ideal" will help a farm manager to select and use the best production methods, facilities, and practices for his particular farm situation.

Sources of Data — Coefficients

Production coefficients and input-output functions were obtained from studies of existing farm operations that used a variety of dairy and forage production practices. These coefficients were used to synthesize an "ideal" farm organization for the purpose of measuring the effects of selected practices and resource restrictions on farm income.

Land Use Capability. In the eight county area, 78 percent of the land in farms was used for crop production, 9 percent was used for permanent pasture, and 13 percent was in such uses as farmstead, woods, roads, and lanes.

Most of the cropland was in a Class II capability which requires moderate conservation practices to be used. It was assumed that at least one acre in five should be in a meadow crop each year. Based on this, the rotation could include a maximum of three years in corn. Conversely, it was assumed the cropland could not be kept in meadow crops indefinitely without reseeding. The life of a good stand of a meadow was assumed to be three years. Thus, the rotation extremes were corn, small grain, meadow, meadow, meadow and corn, corn, corn, small grain, meadow. Soybeans were not included and only one year of small grain was permitted in the rotation. A further restriction consisted of a 15 acre wheat allotment. Any small grain acreage exceeding 15 acres was seeded to oats.

Level of Production. Crop yields and milk production per cow were based on a five year average for the area selected. For the level of managerial input used in the study, yields were established at approximately 30 percent above county averages, (Table 2).

Forage System. Several alternative forage production, harvesting, storage, and feeding systems were considered to determine which would be most desirable. Yield, costs, and labor production coefficients were generated for a typical farm in this area, (Table 3). Meadow crops could be harvested as hay, silage, or as pasture. Production input requirements and returns vary with the system used.

Table 2. Crop Yields Per Acre and Level of Milk Production Per Cow for a Selected West Central Ohio Farm 1960

Item	Unit	Yields	
		Average Management	Above Average Management
Corn	bu.	60	80
Wheat	bu.	27	30[1]
Oats	bu.	45	60
Hay, 1 cutting	ton	1.6	2.0
Hay, 2 cuttings	ton	2.3	3.0
Hay, 3 cuttings	ton	2.9	3.8
Corn silage	ton	12.3	16
Meadow crop silage	ton	4.6	6
Straw (wheat)	ton	1.0	1
Milk	pound	9500[2]	12,500

[1]Wheat yields were held at 30 bushels per acre. High yields would reduce the quality of meadow seeding stands.

[2]Average of EDPM records.

Hay. High quality hay is of vital concern to a dairy farm operator. Making hay without serious weather damage and harvesting the meadow crop at a desirable stage of maturity are important considerations in developing an optimum dairy farm organization.

Field conditioning hay was considered to improve the possibility of making more of the available hay with less weather damage than when conventional methods were used. One ton of field conditioned hay was considered equivalent to 1.1 tons of field cured hay and one ton of field conditioned mow dried hay was considered equivalent to 1.3 tons of conventionally made field cured hay. The difference in nutrient yields was a result of being able to harvest and store more of the total available nutrients than could be preserved when conventional field curing methods were used.

A maximum of 20 tons of top quality (conditioned-mow dried) hay could be purchased. It was considered unrealistic to assume that more than 20 tons of the quality of hay needed for high producing dairy animals could generally be acquired at the price levels used.

Silage. Both corn and grass legume silage were included as possible methods of harvesting, storing, and feeding these crops. Yields, cost of production per acre, and hours of labor required for handling corn and meadow crop silage were obtained from other input-output studies for farm operations of comparable size.

Pasture. It was possible to harvest meadow crops under a variety of pasturing systems. The systems considered were conventional grazing, rotational grazing, and green chop. Rotational grazing increased carrying capacity 25 percent and green chopping increased carrying capacity 40 percent over conventional grazing.* With each of these systems some permanent pasture was available and new seedings could be used for a limited time (Table 7).

* Shaudys, E. T., Sitterley, J. H., and Evans, R. P., "Labor, Equipment, and Costs of Using Rotational Grazing and Green Chop Pasture Systems in Ohio," Research Bulletin 878, Ohio Agricultural Experiment Station, Wooster, Ohio, March 1961.

Table 3. Yields, Prices, Costs, and Labor Required for the Production of Selected Crops on a West Central Ohio Dairy Farm, 1960

Crop	Unit	Yield[1]	Price[2]	Costs Per Acre[3]	Man Hrs. Per Acre
Corn	bu.	80	$ 1.10	$55.00	7.0
Wheat	bu.	30	1.75	39.79	6.1
Oats	bu.	60	.65	43.48	6.4
Hay					
1 cutting[4]	ton	2.0	20.00	18.65	4.2
2 cuttings[4]	ton	3.0	20.00	27.05	6.7
3 cuttings[4]	ton	3.8	20.00	34.58	8.9
Grass silage	ton	6.0	- - - -	27.25	7.9
Corn silage	ton	16.0	- - - -	84.13	10.0
Pasture					
conventional	AUGD[5]	167	- - - -	7.09	1.6
rotational	AUGD[5]	208	- - - -	10.88	3.2
green chop	AUGD[5]	233	- - - -	21.52	4.7

[1]Crop yields were established at 30 percent above county average.
[2]Sale price—buying price was 15 percent above sale price.
[3]Do not include labor or land costs but include storage costs.
[4]Annual costs for harvesting hay with a field chopper. Cost per ton of harvesting hay with a baler was $1.69 higher. The cost of using a field conditioner increased harvesting costs $1.08 per ton and a mow dryer increased costs $2.02 per ton. Nutrient content of a ton of field conditioned hay was equivalent to 1.1 tons of field cured hay and conditioned mow dried hay was equivalent to 1.3 tons of field cured hay.
[5]An Animal Unit Grazing Day is equivalent to 16 pounds of total digestible nutrients.
Note: Other selected commodity prices used are shown in Table 10.

Real Estate Values. Bare land was valued at $180 per acre. This valuation was based on the sale price of commercial farm land and includes tile, roads, ditches, and permanent pasture fences.

Buildings and crop field fences were not included and would add $125 to $175 per acre to the value of farm real estate. Exclusion of buildings and improvements eliminated the prejudice existing facilities would have placed on the development of an optimum farm organization. Buildings needed for storing feed, handling the dairy livestock, and storing equipment were added in any size units needed. The only restrictions placed on buildings were that a herringbone system be used and that at least 75 tons of silage must be fed before a silo could be economically justified.

Annual real estate cost included taxes at 26 mills on 50 percent of the real estate market value, interest at 6 percent of market value and insurance at $4 per $1000 on 80 percent of depreciated building value. Farm buildings were assumed to have a 20 year life and repairs were calculated at 3½ percent of new cost annually.

Available Labor. Labor available for productive farm work was basically limited to family and a small amount of hired seasonal labor. It was established that the operator would be willing to work 3,400 hours per year or about 65 hours per week. Of this 3,400 hours, 25 percent would be non-productive (i.e. used for miscellaneous and maintenance type work) leaving approximately 2,600 hours for productive work. Other family members were able to furnish 600 hours of productive work annually and 400 hours of seasonal hired labor could be employed. The total annual productive labor available was limited to 3,600 hours for the farm.

Table 4. **Upper and Lower Grain and Forage Limits for a Heavy Grain and a Heavy Forage Ration to Satisfy the Annual Nutritional Requirements of One Dairy Cow**

Item	Unit	Ration	
		Forage	Grain
Corn and cob	bu.	64	103
Soybean oil meal	lb.	400	400
Hay (equivalent)	ton	6.2	4.2

On a dairy operation, when a considerable amount of the feeds are produced labor needs vary with the season. Also, some jobs require several workers for efficient operation. In this program the availability of the labor supply was varied by months. It was assumed possible to employ seasonal help during the critical months, to hire some custom services, and that work could be exchanged with neighbors.

Capital. Plans were developed for three levels of capital availability. These were $120,000; $95,000; and $85,000. Capital as used in this study includes the total amount of money needed to acquire and to operate the entire farm business for one year. Both money that would be needed and used for investment in real estate, buildings, livestock, equipment, and operating money was included. Of course, only part of the total capital required had to be owned by the farm family. Perhaps one-half or more of the total could be borrowed (Appendix).

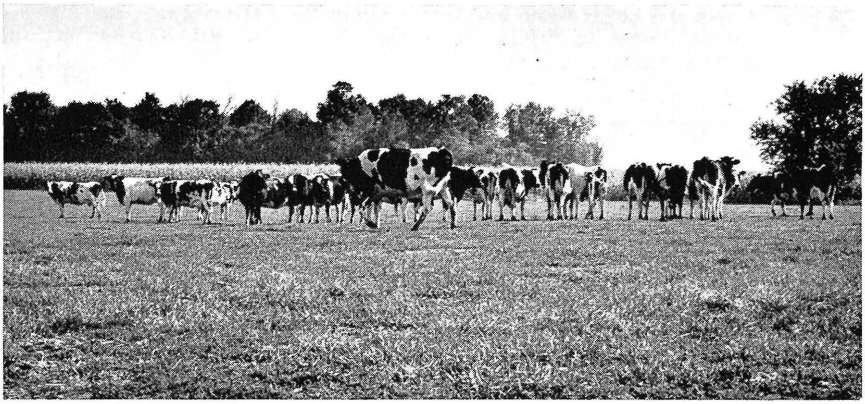
Livestock — Dairy. Dairy was the only livestock enterprise considered. Each dairy unit consisted of one cow producing 12,500 pounds of 3.5 percent milk plus the replacements necessary to maintain the herd. It was assumed that a cow would remain in the herd four productive years.

A herringbone milking parlor-loose housing system and bulk handling of milk was programmed. Milk sold was valued at the blend price received in the Dayton-Springfield market less the hauling cost (Table 10).

Feed required for a cow and her replacement was established at 26.8 pounds of total digestible nutrients per day (Table 8). This feed input was about 15 percent above "Morrison's" standards to compensate for waste, feed rejected by the cow, and variation in nutrient content. Further, the feed ration was established within the following limitation: (1) nutritional requirement for growth, maintenance, production of milk and gestation; (2) stomach capacity of the animal (25 pounds of hay, 75 pounds of silage, 30 pounds of grain or 250 pounds of green chop per day); (3) a minimum of 6 to 8 pounds of dry matter from roughage per day; (4) a minimum of 6 to 8 pounds of concentrate per day; and (5) a minimum of 400 pounds of protein supplement annually (Table 11).

Within the established limits, feeds could be substituted so long as the nutritional needs of the dairy animals were satisfied. Extremes in the ration that could be used satisfactorily are presented in Table 4.

Whenever silage was substituted for hay, pasture, or grain or when hay was substituted for silage, pasture, or grain or any other substitutions were made, adjustments were made in the feeding labor required.



The dairy cow is an important income producer on many corn-belt farms.

The labor required was programmed at 72 hours per cow. The labor required per cow was established from other input-output studies for 30-40 cow one-man family dairy farms. This labor input was distributed by months according to the seasonal work load. Three-fourths of the total labor required to care for the herd was used to milk the cows and for feeding. Hauling manure, maternity care, replacement care, and miscellaneous work accounted for the remainder of the dairy labor.

Capital inputs required per cow and replacement was based on an estimated herd size of 35 cows. Basically, the fixed investment in the dairy activity was for the animals, buildings, land, and equipment needed. The capital required for a cow and her replacement was estimated to be $500 and the buildings and equipment $434. Annual costs and returns per cow were developed and used in selecting the optimum dairy farm organization (Table 9).

DISCUSSION AND FINDINGS

The purpose of this investigation was to develop the dairy farm organization that would permit income maximization on corn belt farms. The nutritional needs of a dairy herd may be supplied in a variety of ways. Availability of capital and methods of handling the meadow crops are important factors in developing an "ideal" one-man family dairy farm organization.

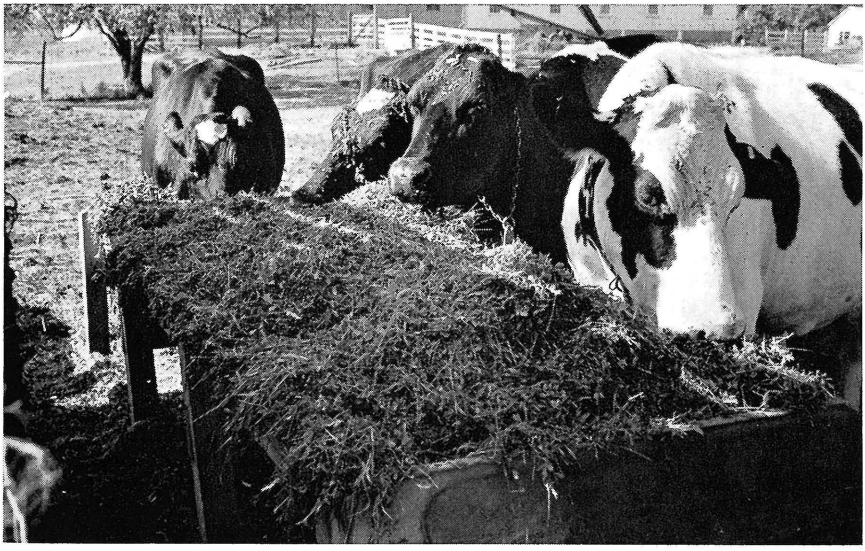
Three levels of capital were assumed to determine the effect the amount of money available would have on the optimal organization of the farm. In addition, six forage handling systems were compared at one level of capital to determine the resulting variations in income among them.

Effects of Capital Availability on the "Ideal" Farm Organization $120,000 *of Capital.* When $120,000 of capital was used in the farm business, labor was found to be the only limiting factor in development of an optimum organization. Capital could be employed as long as the

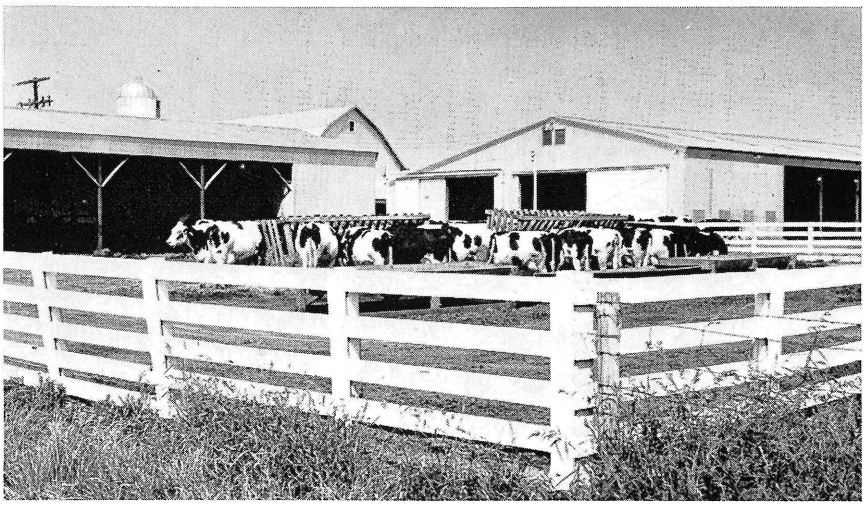
return to capital exceeded the cost of borrowing money. In this study the market cost of such money was assumed to be 6 percent. As soon as the return on borrowed capital equaled the cost of borrowing funds, further expansion of the farm organization requiring more capital was not permitted. In this particular situation, available labor became the most restrictive resource which limited the size of the farm. The available productive labor supply (3,600 hours) was fully employed during the critical periods. Hired labor was assumed available and was employed to the limit permitted.

The resulting organization made the most effective use of the limiting resource (in this case labor) during the most critical or demanding time period to yield the maximum income possible. It included 204 acres of land and 35 cows plus replacements. In addition, a considerable quantity of grain was produced for sale on this farm. The grain sold included all of the wheat that could be produced under the allotment, 4,938 bushels of corn and 294 bushels of oats. An annual family labor and management income of $7,527 was produced. The return to the family owned capital would be in addition to this labor and management income.

The rotation selected was corn, corn, corn, small grain, meadow. A dairy cow and her replacement was fed a ration which included 82 bushels of corn (in the form of corn and cob meal), 3.2 tons of conditioned and mow dried hay, and 142 animal unit grazing days of pasture. In addition, 400 pounds of supplement was fed per cow. Fourteen tons of straw were purchased as the farm did not produce all of the needed bedding and cropland meadows were conventionally grazed.



Green Chopping is an intensive method for satisfying the nutritional needs of the dairy cow.



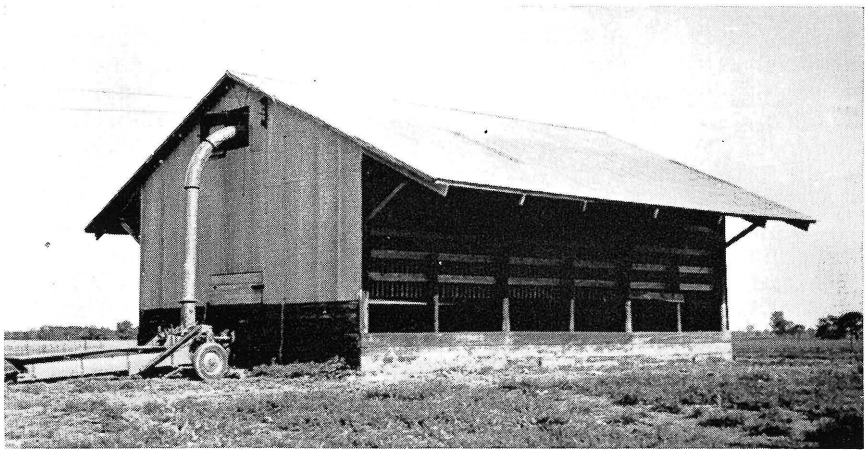
High utility, modern buildings were used on the "ideal" corn belt dairy farm.

$95,000 of Capital. At the $95,000 level, capital was found to be the most limiting factor. All of the available capital was used in the farm organization and more could have been profitably employed. More labor was available than could be productively employed with the available capital. Of the 3,600 hours of productive labor available, 3,384 hours were used on an annual basis. Family income produced with this farm organization was $5,977 or $1,550 less than when $120,000 of capital was used.

Under the $95,000 capital limitation, the acreage in the farm was reduced to 133 acres, but 37 cows were kept or two more than at the higher capital level. The ration fed to the dairy herd contained less grain but more forage than when more capital was available. A rotation of corn, corn, small grain, meadow, meadow was selected. This farm had exactly the same availability of all resources as the previous farm organization except for capital. The ration fed per cow and replacement to the dairy herd consisted of 79 bushels of corn, 2.7 tons of hay, 160 AUGD* of pasture, 2.1 tons of corn silage and 400 pounds of supplement. More straw (28 tons) was purchased, and the cropland meadows were rotationally grazed.

$85,000 of Capital. The availability of capital was further restricted to determine what effect it would have on the optimum farm organization. At this level of available capital, farm size was reduced to 104 acres and only 33 cows and needed replacements could be kept. The labor that could be productively employed was reduced to 3,018 hours. A rotation of corn, small grain, meadow, meadow, meadow was selected and more forage was used in the ration than when more capital was

*Animal unit grazing days



Making and self-feeding chopped hay reduces forage handling labor requirements.

available. The ration included 65 bushels of corn, 2.0 tons of hay, 180 AUGD of pasture, 3.8 tons of corn silage and 400 pounds of supplement. Again straw had to be purchased, oats were sold, and cropland pastures were rotationally grazed.

With all three levels of capital, it was most profitable to maintain as many cows as could be financed and well cared for during the period of peak labor demand (Table 5). Capital was the most restrictive resource for this farm at the $85,000 and $95,000 availability levels. More labor was available than could be profitably utilized with these amounts of capital. Consequently, some of the labor was not employed.

Table 5. Optimum Forage Systems and Herd Size for a One-Man Family Dairy Operation for Selected Levels of Capital Available, Western Ohio, 1960

Item	Unit	Capital[1] $120,000	$95,000	$85,000
Cows in milk	cow	35	37	33
Size of farm	acre	204	133	104
Basic crop rotation	. . .	C-C-C-SG-M	C-C-SG-M-M	C-SG-M-M-M
Corn & cob meal per cow	bu.	82	79	65
Hay per cow[2]	ton	3.2	2.7	2.0
Pasture days per cow[3]	augd	142	160	180
Corn silage per cow[4]	ton	- - - -	2.1	3.8
Supplement per cow	pounds	400	400	400
Straw bought	ton	14	28	25
Corn sold	bu.	4,938	- - - -	- - -
Oats sold	bu.	294	192	170
Labor used	hour	3,600[5]	3,384	3,018
Family labor and management income	dollar	$7,527.02	$5,977.58	$5,331.75

[1]Total capital outlay needed to implement system at new prices.
[2]Conditioned and mow dried.
[3]Pasture conventionally grazed with $120,000 of capital and rotationally grazed at other levels of capital availability.
[4]Stored in bunker silos.
[5]Total hours of productive labor available.

At the $120,000 level, all of the labor was employed. Within the limitations of the study, increasing the availability of capital above the $120,000 level would not make possible the development of an organization that would further increase income with the existing labor supply. Cow numbers were increased from 33 head at the $85,000 level to 37 head at the $95,000 level then reduced to 35 head at the $120,000 level. All of the productive labor was employed at the $120,000 level. When $120,000 of capital was available, income was maximized by reducing cow numbers to 35 head which released labor which was then combined with capital in the form of land for the production of crops for sale. If this labor was used for the dairy, some of the available capital (in the form of cropland) would not have been included in the organization and less income would have been earned.

Maximum family income was earned with the organization incorporating the best balance of resource use (the $120,000 capital level). High producing cows (12,500 pounds of milk) were found to be worthy competitors with the production of grain for sale on some corn belt farms.

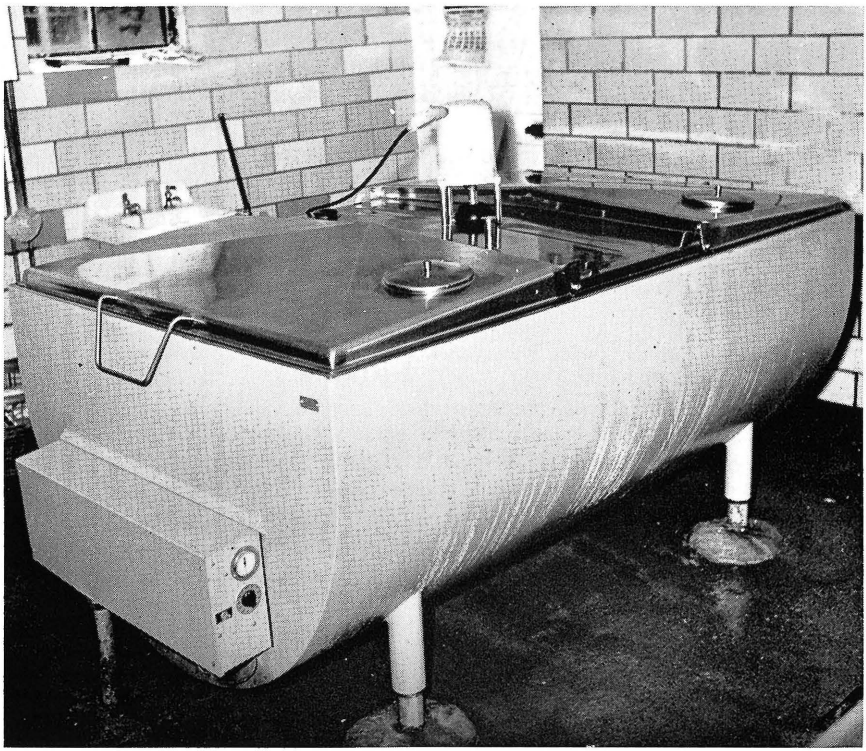
Acreage in the farm was found to be primarily a function of the available capital. As more capital was made available, the size of the farm acreage was increased. The rotation and the dairy ration varied with the relative availability of capital and labor. More nutrients could be produced in the form of grain than in the form of forage per hour of labor when adequate capital was available. A heavy grain rotation at either the $85,000 or $95,000 level of capital would have permitted fewer hours of labor to be employed than when more forage crops were included because of the seasonal demands. Conversely, the available productive labor supply could not have handled the work load of a heavy forage rotation on the $120,000 capital level and harvested the quantity and quality of forage needed for high producing dairy cows.

Income Comparisons of Selected Forage Handling Systems

Six systems of handling forage crops were compared at the $95,000 capital availability input level. The six systems were: (1) field cured and baled hay, (2) conditioned field cured baled hay, (3) conditioned, mow dried baled hay, (4) corn silage and field cured baled hay, (5) corn silage and conditioned, mow dried chopped hay, and (6) a dry lot system. These systems were compared to determine and select the system or systems that were most adaptable to corn belt conditions.

These comparisons revealed only minor differences in family labor and management income. Cow numbers varied from 37 to 39 cows and farm size from 130 to 135 acres. The only exception to this occurred when a dry-lot dairy system was considered for which the farm size was established beforehand at 110 acres It is of interest to note that while hay was purchased in three of the selected systems no hay was purchased when a dry-lot system was used.

Field conditioned, baled mow-dried hay had the highest family income potential of any of these six systems. Family labor and management income earned with this system was found to be $283 higher than



Capital for investment in equipment and facilities is required to meet present day market demands.

when a corn silage and field-cured baled hay system was used and $286 higher than when meadows were harvested as field-conditioned baled hay. The harvesting of the forage needed for the dairy herd as field-cured baled hay or harvesting corn silage and field-conditioned chopped and mow-dried hay yielded a family income of $338 to $336 less respectively than harvesting forage as conditioned, baled mow-dried hay.

The dry lot system of handling the dairy herd on the corn belt farm described did not yield as much family income as the other systems. It was limited to a smaller land area, which may have had some effect on the income earned. Many other features of the dry-lot system were quite similar to the other systems such as cow numbers, availability of capital and hours of labor employed. There was more grain used in the ration fed to the dairy herd and a considerable quantity (1295 bushels) of corn was purchased. All of the forage fed was produced on the farm and the harvested forages were stored in the form of hay—not silage. Labor was more productively employed by caring for the dairy animals than by harvesting and feeding silage which required more labor time per pound of TDN than hay.

Table 6. Optimum Organization of a One-Man Dairy Operation Under Selected Forage Systems Western Ohio, 1950 (With $95,000 of capital available)

Item	Unit	Field Cured Baled Hay	Conditioned Baled Hay	Conditioned Mow-dried Baled Hay	Silage and Field-Cured Baled Hay	Silage and Conditioned Mow-dried Chopped Hay	Dry Lot System [1]
Cows in milk	cow	37	38	38	39	37	39
Size of farm	acre	135	131	130	130	133	110[2]
Corn[3]	bu.	90	91	89	74	80	93
Hay[3]	ton	2.4	2.4	2.4	1.9	2.2	2.5
Pasture							
rotational grazed[3]	AUGD	160	157	163	157	152	
green chop[3]	AUGD						148
Corn silage[3]	ton				3.7	2.1	
Hay purchased	ton	20	16		20		
Straw purchased	ton	28	29	29	30	28	34
Corn purchased	bu.						1,295
Corn sold	bu.	274					
Oats sold	bu.	193	189	188	188	192	158
Labor used	hr.	3,397	3,415	3,402	3,521	3,384	3,391
Family labor and management income		$5,996	$6,048	$6,334	$6,051	$5,998	$5,747

[1]Included green-chopped pasture, conditioned chopped and mow-dried hay (no field grazing)
[2]Limited to 110 acres
[3]Fed per cow and replacement annually

Note: The basic crop rotation was C C SG M M, 400 pounds of supplement were fed per cow and replacement annually under all forage programs.

Field chopping hay was selected in preference to baling. Yields for baling and field chopping hay were the same, but the baling costs and labor requirements were slightly higher than for field chopping. However, in order to produce hay of comparable palatability when field chopping was practiced, mow-drying was required, which increased the cost. Under certain farm conditions, this method of harvest may be highly desirable — especially on farms with large volumes of hay to be harvested and limited amounts of labor available.

Additional hay was purchased when three of the four forage systems were used. It was assumed that hay of comparable quality to that produced on the farm would be purchased.

The improved quality of hay produced when a field conditioner and mow-dryer were used, more than offset the added cost. Family labor and management income was increased by the addition of these practices. Another real advantage of using a field hay conditioner and/or mow-dryer is the reduction in risk of hay damage or loss from adverse weather conditions.

The program included the possibility of conventional grazing, rotational grazing and the green chopping of the meadow crops. At the $95,000 capital level, a rotational system of grazing pastures was selected. The only exception was the dry-lot system where it was excluded as a possibility.

The amount of labor employed with these six systems was comparable, although some differences do exist, as to when peak labor demands occur. In no case was all of the available labor fully employed. Capital became limiting before all of the available labor could be used productively.

Silage

It was found that more income could be earned by feeding high quality hay (conditioned or mow-dried) than by feeding silage to high producing cows. When a silo was assumed to be on the farm, thereby eliminating the use of capital for the purchase of a silo, corn and not grass legume silage was selected as the most profitable. The use of corn silage was favored over grass legume silage because of the relatively lighter demands on labor for competing jobs during September when corn silage would be made than in the May - June period when grass legume silage would be harvested.

Farmers with larger amounts of hay to make or with more labor available during peak labor periods would find the use of silage more advantageous than was found true on this size farm operation.

SUMMARY AND CONCLUSIONS

The capital available greatly influences the optimum organization of other resources available on corn-belt dairy farms. The rotation, the ration fed to the dairy herd, the method of harvesting and feeding the meadow crops, and family income varied with the availability of capital.

First, a corn-belt dairy farm with ample capital was organized. With this organizaton, the available labor was fully employed and a

relatively heavy grain, light forage ration was fed. The maximum amount of corn that was permitted was produced and a considerable amount was sold. When labor was a limiting factor, dairy cow numbers were reduced in favor of producing cash grain.

When a farm was organized with less capital available, the amount of forage in the ration was increased and corn decreased. It was found that the optimum number of cows kept in the dairy herd was affected by the capital available. The maximum number of cows was kept at the $95,000 capital level. When more capital was available, the available labor was not adequate to care for the cows and to use all of the capital that could be invested profitably. Conversely, when less than $95,000 of capital was available, both the size of the farm and cow numbers were reduced. At this level of resource availability, the farm was operated at a more intensive level with the production of more forage in the rotation, which was used in the form of silage, hay and pasture, and less grain was fed per cow than when more capital was available.

When several systems of handling the forage crops were compared, the differences found in farm family income were small, although they were worthy of consideration. Other organizational differences such as practices associated with the care, production, and handling of the dairy cows appeared to be more important factors affecting income than the method selected for harvesting, storing, and feeding the forage crops. In general, rotational grazing of pasture and the use of a field hay conditioner and mow-dryer was desirable. The value of the improvement in hay quality from using a field hay conditioner was considerably greater than the added cost. This was particularly true for the first cutting of hay. The use of a mow-dryer was found to be profitable but offered less advantage than the use of a field hay conditioner.

Supplemental feeding of the dairy herd during the pasture season rather than attempting to provide the needed nutrients from pasture was found to be economically desirable. Often in the past it has been recommended that a farmer should strive to produce all of the feeds (except supplement) especially all of the forage needed for his herd. Some forages and grains were profitably purchasd on these farms and were fed to the cows during both the winter and summer seasons. Organizationally, the balance among the labor, capital, and other resources was much more important than the source of feed.

The making, storing, and feeding of silage was one of the last alternative forage handling methods considered for a farm of this size under corn belt conditions. Making high quality hay was a cheaper source of feed nutrients than silage when the capital cost of erecting a silo was considered. On a large, well-financed farm operation other possible uses of the resources offered greater returns than was possible with silage. When labor was relatively more abundant, a silo was more favorably considered. When a silo was assumed to be on the farm, thereby eliminating the cost of the silo construction from the program, it was filled with corn rather than a meadow crop. This was found to be due to the relative availability of labor at different seasons for harvesting the silage crop.

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APPENDIX

Type of Capital Needed at the $95,000 Level

The total capital required ($95,000) was divided into $45,000 for land and buildings, $22,000 for machinery and equipment (new prices), $18,000 for dairy animals, and $10,000 operating capital. Assuming that 30 - 35 percent equity is needed in land and buildings and 60 percent for chattels, $45,000 to $50,000 could be borrowed.

With a dairy operation, receipts are fairly stable and furnish a constant flow of income. Thus, only about one-fourth or $2,500 of the total $10,000 operating capital needed annually would be required at any one time during the year.

This means that a minimum of $40,000 of equity capital would be needed to establish and operate this farm.

Equity Investment	Amount
Land and buildings	$13,500
Machinery and equipment	13,000
Livestock	11,000
Operating capital	2,500
Total equity	$40,000

If used or partially depreciated machinery were included or custom operators were employed, machinery investment might be reduced considerably.

With an equity of $40,000, the return to capital at 6 percent would be $2,400 annually. Family labor and management income at the 95,000 capital investment level was $5,977 and farm income was $8,377. The farm family in this situation would actually have $8,377 for family living, debt repayment, and new investment each year.

Table 7. Animal Unit Grazing Days by Months, Selected Pasture Systems, Rotation and Permanent Pasture, West Central Ohio, 1960

Type of Pasture	Animal Unit Grazing Days[1]					
	May	June	July	Aug.	Sept.	Oct.
Conventional	41	50	22	22	22	11
Rotational						
full season	51	62	27	27	27	14
after 1st crop hay	--	--	31	31	24	12
after 2nd crop hay	----	-	----	----	23	11
Green chop (full season)	57	70	30	30	30	16
New seeding	--	--	--	12	8	--
Permanent pasture	33	33	14	7	14	14

[1]An animal unit grazing day is equivalent to 16 pounds of total digestible nutrients.

Table 8. Pounds of Nutrients Needed Per Cow and Replacement Daily and Annually

Item	Lbs. of TDN Required	
	Daily	Annually
Body maintenance	10.9	4,004
Milk production 12,500 lbs.	12.1	4,420
Gestation	.2	76
Replacement	3.6	1,300
Total	26.8	9,800

Source: Frank B. Morrison, Feeds and Feeding, the Morrison Publishing Company, 21st Edition, 1958.

Table 9. Annual Costs and Returns Per Cow for a Selected West Central Ohio Dairy Farm, 1960
(excludes cost of labor, home produced feed and bedding)

Item	Value
Purchased feed, grinding, and veterinary	$ 51.30
Livestock	
interest	30.00
tax	6.55
insurance	1.60
depreciation	70.00
Buildings and equipment	
interest	26.00
tax	5.61
insurance	1.39
depreciation	21.70
repairs	13.00
Costs	$227.15
Milk receipts	$466.48
Cull cows	34.29
Veal calves	15.14
Manure	21.00
Returns	$536.91
Difference[1]	$309.76

[1]Available to pay for labor, home produced feeds and bedding.

Table 10. Prices of Selected Commodities Sold and Used in Production, West Central Ohio, 1956-1960

Commodity	Unit	Price	
		Sell	Buy
Straw	ton	$12.00	$14.00
Milk	cwt.	3.92	- - -
Veal calves	cwt.	25.00	- - -
Cull cows	cwt.	12.30	- - -

Table 11. Nutrient Content and Grain-Forage Substitution Rates of Selected Feeds for Dairy Cows

Item	Unit	Pounds of TDN	Equivalents			
			Corn (bu.)	Hay (ton)	Silage (ton)	Pasture (AUGD)
Corn	bu.	52.5	1	.05	.15	3.3
Hay	ton	1000	19.08	1	2.94	63
Silage	ton	340	648	.34	1	21.3
Pasture	AUGD	16	.30	.02	.05	1